Coursera Machine Learning Project

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For this project I'll select 4 Machine Learning Models: Trees Model, Linear Discriminant Analysis (LDA) Model, Classification Trees Model and Support Vector Modle. I'll take the Training Dataset, spilit it into a Traning Data Set to build the model using 75% of the data and use the other 25% of the data for a Testing Data Set to Test the Model. I'll use In Sample Accuracy/Error, Out of Sample (Test Set) Accuracy and Kappa Value to ascertain the best model. Finally I'll use the best model to calculate the results for a "Test Case" Dataset which was provided for this Project.

This Script will:

Data Preparation

1- Read training data into a dataframe and assign Factor Levels.

2-Change blank value to na, remove columns with na.

3-Split train data set into training and test sets

Model Fitting

4-Fit a model on Trees Model, Linear Discriminant Analysis (LDA) Model, Classification Trees Model and Support Vector Modle

Model Summaries

5-Summary Results: In Sample Error, Out-of-Sample Error/Accuracy and Kappa.

Predict 20 Test Cases

6-Calculate predicted results using the best model (Classification Trees Model) in this case on the test data set provided.

Data Preparation

```
##########################Coursera Practicle Machine Learning Class Projec
##########################Jeff Roberts
##########################Date: 18-Sept. 2014
##########################Data from: http://groupware.les.inf.puc-rio.br/work.jsf?p
1=10335
library(plyr)
library(caret)
```

```
## Loading required package: lattice
## Loading required package: ggplot2
```

```
library(rpart)
library(MASS)
library(glmnet)
```

```
## Loading required package: Matrix
## Loaded glmnet 1.9-8
```

```
library(C50)
library(e1071)
set.seed(13)

###Read training data into a dataframe and assign Factor Levels
train<-read.csv("pml-training.csv")
test<-read.csv("pml-testing.csv")
revalue(train$classe, c("A" = "Sitting-down", "B"="Standing-up", "C"="Stading",
"D"="Walking", "E"="Sitting")) -> train$classe

####Change blank value to na, remove columns with na
train[train==""] <- NA
train <- train[, colSums(is.na(train)) == 0]
test[test==""] <- NA
test <- test[, colSums(is.na(test)) == 0]

##########split train into training and test sets
inTrain<-createDataPartition(y=train$classe, p=.75, list=FALSE)
training<-train[inTrain,]
testing<-train[-inTrain,]
training<-training[,-c(1:7)]
testing<-testing[,-c(1:7)]
```

Model Fitting

```
##############################################Fit a model on trees
model1<-train(classe~., data=training, method="rpart")
####insample errors
e1<-(predict(model1, newdata=training)==training$classe)
e1<-as.numeric(sum(e1=="TRUE"))/nrow(training)

###Predict on test dataset
predict1<-predict(model1, newdata=testing)

###Confusion Matrix
cmatrix1<-confusionMatrix(predict1, testing$classe)
c1<-as.matrix(cmatrix1$overall)
r1.1<-c1[1,]
r1.2<-c1[2,]
##############################################Fit a model on Linear Discriminant Analy
sis Model based predictions

model2 = train(classe ~ .,data=training,method="lda")
####insample errors
e2<-(predict(model2, newdata=training)==training$classe)
e2<-as.numeric(sum(e2=="TRUE"))/nrow(training)

###Predict on test dataset
predict2<-predict(model2, newdata=testing)

###Confusion Matrix
cmatrix2<-confusionMatrix(predict2, testing$classe)
c2<-as.matrix(cmatrix2$overall)
r2.1<-c2[1,]
r2.2<-c2[2,]
##############################################Fit a model on C5.0 classification trees
model3<-C5.0(classe~.,data=training)
####insample errors
e3<-(predict(model3, newdata=training)==training$classe)
e3<-as.numeric(sum(e3=="TRUE"))/nrow(training)

###Predict on test dataset
predict3<-predict(model3, newdata=testing)

###Confusion Matrix
cmatrix3<-confusionMatrix(predict3, testing$classe)
c3<-as.matrix(cmatrix3$overall)
r3.1<-c3[1,]
r3.2<-c3[2,]
```

```
##############################################Fit a model on Support Vector
model4<-svm(classe~., data = training)
####insample errors
e4<-(predict(model4, newdata=training)==training$classe)
e4<-as.numeric(sum(e4=="TRUE"))/nrow(training)

###Predict on test dataset
predict4<-predict(model4, newdata=testing)

###Confusion Matrix
cmatrix4<-confusionMatrix(predict4, testing$classe)
c4<-as.matrix(cmatrix4$overall)
r4.1<-c4[1,]
r4.2<-c4[2,]
```

Model Summaries

```
###############Summary Results
###In-Sample Errors
e<-cbind(c(e1, e2, e3, e4))
colnames(e) <- "In-Sample Accuracy"
rownames(e)<- c("Trees Model", "LDA Model", "Classification Trees Model", "Support V
ector Model")

###accuracy
a<-cbind(c(r1.1, r2.1, r3.1, r4.1))
colnames(a) <- "Accuracy"
rownames(a)<- c("Trees Model", "LDA Model", "Classification Trees Model", "Support V
ector Model")
###kappa
b<-cbind(c(r1.2, r2.2, r3.2, r4.2))
colnames(b) <- "Kappa"
rownames(b)<- c("Trees Model", "LDA Model", "Classification Trees Model", "Support V
ector Model")
e;a;b
```

```
##                             In-Sample Accuracy
## Trees Model                             0.4948
## LDA Model                               0.7060
## Classification Trees Model              0.9915
## Support Vector Model                    0.9507
```

```
##                              Accuracy
## Trees Model                    0.4978
## LDA Model                      0.7025
## Classification Trees Model     0.9586
## Support Vector Model           0.9494
```

```
##                               Kappa
## Trees Model                  0.3443
## LDA Model                    0.6235
## Classification Trees Model 0.9476
## Support Vector Model         0.9360
```

Model Summaries/Discussion

It can be seen from all three talbes that the Classification Trees Model is the best model. It has the highest In-Sample Accuracy/Lowest Error at 99.15%, the highest Out-of-Sampler Accuracy at 95.86% and the highest Kappa Value at 94.76%.

Classification Trees Model and Confusion Matrix Results

```
################Print Model and Confusion Matrix Results
model4
```

```
##
## Call:
## svm(formula = classe ~ ., data = training)
##
##
## Parameters:
##    SVM-Type:  C-classification
##  SVM-Kernel:  radial
##        cost:  1
##       gamma:  0.01923
##
## Number of Support Vectors:  6774
```

```
cmatrix3
```

```
## Confusion Matrix and Statistics
##
##                Reference
## Prediction     Sitting-down Standing-up Stading Walking Sitting
##   Sitting-down         1367           8       6       2      10
##   Standing-up            19         910      28       6       8
##   Stading                 6          16     791      30       7
##   Walking                 2           6      22     761       4
##   Sitting                 1           9       8       5     872
##
## Overall Statistics
##
##                Accuracy : 0.959
##                  95% CI : (0.953, 0.964)
##     No Information Rate : 0.284
##     P-Value [Acc > NIR] : <2e-16
##
##                   Kappa : 0.948
##  Mcnemar's Test P-Value : 0.0841
##
## Statistics by Class:
##
##                      Class: Sitting-down Class: Standing-up Class: Stading
## Sensitivity                        0.980              0.959          0.925
## Specificity                        0.993              0.985          0.985
## Pos Pred Value                     0.981              0.937          0.931
## Neg Pred Value                     0.992              0.990          0.984
## Prevalence                         0.284              0.194          0.174
## Detection Rate                     0.279              0.186          0.161
## Detection Prevalence               0.284              0.198          0.173
## Balanced Accuracy                  0.986              0.972          0.955
##                      Class: Walking Class: Sitting
## Sensitivity                  0.947          0.968
## Specificity                  0.992          0.994
## Pos Pred Value               0.957          0.974
## Neg Pred Value               0.990          0.993
## Prevalence                   0.164          0.184
## Detection Rate               0.155          0.178
## Detection Prevalence         0.162          0.183
## Balanced Accuracy            0.969          0.981
```

Predict 20 Test Cases

```
predict.t<-predict(model3, newdata=test)
predict.t
```

```
##  [1] Standing-up  Sitting-down Standing-up  Sitting-down Sitting-down
##  [6] Sitting      Stading      Walking      Sitting-down Sitting-down
## [11] Standing-up  Stading      Standing-up  Sitting-down Sitting
## [16] Sitting      Sitting-down Standing-up  Standing-up  Standing-up
## Levels: Sitting-down Standing-up Stading Walking Sitting
```

Appendix (Classification Trees Model and Statistics)

```
summary(model3)
```

```
##
## Call:
## C5.0.formula(formula = classe ~ ., data = training)
##
##
## C5.0 [Release 2.07 GPL Edition]      Fri Sep 19 23:31:58 2014
## -------------------------------
##
## Class specified by attribute `outcome'
##
## Read 14718 cases (53 attributes) from undefined.data
##
## Decision tree:
##
## roll_belt > 130:
## :...yaw_belt <= 152: Sitting (1205)
## :   yaw_belt > 152:
## :   :...roll_arm <= 36: Sitting (16)
## :       roll_arm > 36: Sitting-down (10)
## roll_belt <= 130:
## :...pitch_forearm <= -34:
##     :...gyros_arm_x <= 0.88: Sitting-down (1147)
##     :   gyros_arm_x > 0.88:
##     :   :...gyros_dumbbell_y <= 0.11: Sitting-down (35)
##     :       gyros_dumbbell_y > 0.11:
##     :       :...gyros_belt_x <= 0: Standing-up (6)
##     :           gyros_belt_x > 0: Sitting-down (2)
##     pitch_forearm > -34:
##     :...roll_belt <= -0.84:
##         :...accel_forearm_z > 41:
##         :   :...magnet_belt_x <= 82: Walking (241)
##         :   :   magnet_belt_x > 82: Sitting (26)
##         :   accel_forearm_z <= 41:
##         :   :...gyros_forearm_x <= 0.82: Sitting (325)
##         :       gyros_forearm_x > 0.82:
##         :       :...roll_forearm <= 120: Sitting-down (9)
##         :           roll_forearm > 120: Sitting (24)
##         roll_belt > -0.84:
##         :...gyros_belt_z > 0.07:
##             :...magnet_belt_z <= -482: Walking (65)
##             :   magnet_belt_z > -482:
##             :   :...roll_forearm <= -177:
##             :       :...roll_arm > 116: Standing-up (9)
##             :       :   roll_arm <= 116:
```

```
##             :       :   :...accel_forearm_z <= -10: Sitting (2)
##             :       :       accel_forearm_z > -10: Walking (6)
##             :       roll_forearm > -177:
##             :       :...magnet_belt_y <= 628:
##             :           :...yaw_belt > 166: Walking (9/1)
##             :           :   yaw_belt <= 166:
##             :           :   :...magnet_forearm_x <= 427: Sitting (237/3)
##             :           :       magnet_forearm_x > 427:
##             :           :       :...magnet_dumbbell_x <= -435: Walking (4)
##             :           :           magnet_dumbbell_x > -435: Sitting (2)
##             :           magnet_belt_y > 628:
##             :           :...magnet_forearm_x > -334: Sitting (4/1)
##             :               magnet_forearm_x <= -334:
##             :               :...gyros_arm_x > 1.08: Standing-up (2)
##             :                   gyros_arm_x <= 1.08:
##             :                   :...magnet_dumbbell_z <= 53: Sitting-down (3)
##             :                       magnet_dumbbell_z > 53: Walking (5)
##             gyros_belt_z <= 0.07:
##             :...accel_dumbbell_x > 41:
##                 :...gyros_belt_x <= -0.35:
##                 :   :...gyros_forearm_z > 0.97: Sitting (10)
##                 :   :   gyros_forearm_z <= 0.97:
##                 :   :   :...accel_arm_x <= 120: Standing-up (4)
##                 :   :       accel_arm_x > 120:
##                 :   :       :...yaw_belt <= -5.59: Walking (4)
##                 :   :           yaw_belt > -5.59:
##                 :   :           :...pitch_belt <= 26: Stading (6)
##                 :   :               pitch_belt > 26: Sitting-down (4)
##                 :   gyros_belt_x > -0.35:
##                 :   :...magnet_belt_z > -339:
##                 :       :...magnet_belt_x <= 170: Standing-up (280/1)
##                 :       :   magnet_belt_x > 170:
##                 :       :   :...pitch_belt <= -42.9: Standing-up (3)
##                 :       :       pitch_belt > -42.9: Stading (7)
##                 :       magnet_belt_z <= -339:
##                 :       :...roll_dumbbell > 49.4083:
##                 :           :...total_accel_dumbbell <= 10: Sitting-down (11/1)
##                 :           :   total_accel_dumbbell > 10:
##                 :           :   :...gyros_dumbbell_x <= 0.87: Sitting (185)
##                 :           :       gyros_dumbbell_x > 0.87: Standing-up (5/1)
##                 :           roll_dumbbell <= 49.4083:
##                 :           :...magnet_dumbbell_x <= -223: Sitting (8/1)
##                 :               magnet_dumbbell_x > -223:
##                 :               :...magnet_forearm_z <= -589: Sitting-down (7)
```

```
##                 :                   magnet_forearm_z > -589: [S1]
##                 accel_dumbbell_x <= 41:
##                 :...gyros_belt_y <= -0.11:
##                     :...magnet_belt_z <= -473: Walking (74)
##                     :   magnet_belt_z > -473: Sitting (64)
##                     gyros_belt_y > -0.11:
##                     :...yaw_belt > 169:
##                         :...pitch_belt <= -45.1:
##                         :   :...magnet_forearm_x <= -322: Walking (33)
##                         :   :   magnet_forearm_x > -322: Standing-up (8)
##                         :   pitch_belt > -45.1:
##                         :   :...gyros_belt_x <= 0.02:
##                         :       :...magnet_forearm_x <= 218: Standing-up (12)
##                         :       :   magnet_forearm_x > 218: Sitting-down (7)
##                         :       gyros_belt_x > 0.02:
##                         :       :...gyros_belt_z > -0.11: [S2]
##                         :           gyros_belt_z <= -0.11:
##                         :           :...pitch_arm <= 81.1: Sitting-down (501)
##                         :               pitch_arm > 81.1: [S3]
##                         yaw_belt <= 169:
##                         :...roll_belt > 128:
##                             :...magnet_forearm_x <= -190: Sitting (66/1)
##                             :   magnet_forearm_x > -190:
##                             :   :...pitch_forearm <= 11.3: Sitting-down (198)
##                             :       pitch_forearm > 11.3: Sitting (5)
##                             roll_belt <= 128:
##                             :...total_accel_forearm <= 4: Sitting-down (188/1)
##                                 total_accel_forearm > 4:
##                                 :...pitch_belt <= -43:
##                                     :...accel_belt_x > 58:
##                                     :   :...roll_belt <= 126: Standing-up (2)
##                                     :   :   roll_belt > 126: Walking (10)
##                                     :   accel_belt_x <= 58:
##                                     :   :...magnet_arm_z > 611: [S4]
##                                     :       magnet_arm_z <= 611:
##                                     :       :...magnet_belt_x <= 171: [S5]
##                                     :           magnet_belt_x > 171: [S6]
##                                     pitch_belt > -43:
##                                     :...yaw_arm <= -115:
##                                         :...roll_forearm > 113: [S7]
##                                         :   roll_forearm <= 113: [S8]
##                                         yaw_arm > -115:
##                                         :...gyros_dumbbell_y <= -0.43:
##                                             :...pitch_arm > 21.5: [S9]
```

```
##                                                 :   pitch_arm <= 21.5:
##                                                 :   :...magnet_dumbbell_z <= 223: [S1
0]
##                                                 :       magnet_dumbbell_z > 223: [S1
1]
##                                                 gyros_dumbbell_y > -0.43:
##                                                 :...gyros_dumbbell_y > 0.56:
##                                                     :...magnet_belt_z <= -377: [S12]
##                                                     :   magnet_belt_z > -377:
##                                                     :   :...magnet_arm_x <= -411: [S1
3]
##                                                     :       magnet_arm_x > -411:
##                                                     :       :...yaw_belt > -2.97: [S1
4]
##                                                     :           yaw_belt <= -2.97: [S
15]
##                                                     gyros_dumbbell_y <= 0.56:
##                                                     :...magnet_dumbbell_z <= -24:
##                                                         :...magnet_arm_z <= -288: [S1
6]
##                                                         :   magnet_arm_z > -288:
##                                                         :   :...gyros_arm_x <= -3.2:
[S17]
##                                                         :       gyros_arm_x > -3.2:
[S18]
##                                                         magnet_dumbbell_z > -24: [S1
9]
##
## SubTree [S1]
##
## total_accel_arm <= 34: Standing-up (225)
## total_accel_arm > 34: Sitting-down (5/1)
##
## SubTree [S2]
##
## total_accel_dumbbell <= 17: Standing-up (4)
## total_accel_dumbbell > 17: Sitting-down (9)
##
## SubTree [S3]
##
## magnet_arm_y <= 322: Sitting-down (15)
## magnet_arm_y > 322: Standing-up (2)
##
## SubTree [S4]
```

```
##
## gyros_arm_x <= -0.79: Standing-up (5/1)
## gyros_arm_x > -0.79: Sitting-down (7)
##
## SubTree [S5]
##
## accel_forearm_z > -43: Standing-up (401/4)
## accel_forearm_z <= -43:
## :...roll_belt > 125: Standing-up (18)
##     roll_belt <= 125:
##     :...roll_belt <= 124: Sitting-down (2)
##         roll_belt > 124: Stading (4)
##
## SubTree [S6]
##
## gyros_belt_y > 0.16: Sitting (5)
## gyros_belt_y <= 0.16:
## :...magnet_belt_y <= 515: Sitting (3)
##     magnet_belt_y > 515:
##     :...pitch_belt <= -44.1: Standing-up (51/1)
##         pitch_belt > -44.1:
##         :...roll_belt > 125: Standing-up (12)
##             roll_belt <= 125:
##             :...roll_arm > 25.8: Standing-up (13)
##                 roll_arm <= 25.8:
##                 :...accel_belt_z <= -162: Standing-up (2)
##                     accel_belt_z > -162: Stading (45/1)
##
## SubTree [S7]
##
## roll_belt > 122: Standing-up (30)
## roll_belt <= 122:
## :...accel_forearm_z <= -156: Stading (25)
##     accel_forearm_z > -156: Standing-up (3/1)
##
## SubTree [S8]
##
## roll_forearm <= -93.3: Standing-up (15/1)
## roll_forearm > -93.3:
## :...magnet_dumbbell_z > 64:
##     :...roll_belt <= 125: Sitting-down (11)
##     :   roll_belt > 125: Standing-up (4)
##     magnet_dumbbell_z <= 64:
##     :...gyros_belt_z > -0.49: Sitting-down (306)
```

```
##         gyros_belt_z <= -0.49:
##         :...gyros_belt_z <= -0.51: Standing-up (2)
##             gyros_belt_z > -0.51: Sitting-down (7)
##
## SubTree [S9]
##
## accel_belt_z > -66: Sitting-down (4)
## accel_belt_z <= -66:
## :...yaw_belt <= -4.67: Walking (7)
##     yaw_belt > -4.67:
##     :...roll_belt <= 120: Standing-up (5)
##         roll_belt > 120:
##         :...gyros_arm_y <= 1.19: Stading (46)
##             gyros_arm_y > 1.19: Standing-up (4)
##
## SubTree [S10]
##
## magnet_belt_y <= 571: Sitting (14)
## magnet_belt_y > 571:
## :...accel_belt_z <= 42:
##     :...pitch_belt <= 1.33:
##     :   :...total_accel_belt <= 11: Sitting (4/1)
##     :   :   total_accel_belt > 11: Stading (4/1)
##     :   pitch_belt > 1.33:
##     :   :...gyros_forearm_z <= -1.74:
##     :       :...total_accel_arm <= 5: Stading (4)
##     :       :   total_accel_arm > 5: Standing-up (4)
##     :       gyros_forearm_z > -1.74:
##     :       :...accel_arm_x <= 252: Standing-up (316/8)
##     :           accel_arm_x > 252:
##     :           :...accel_forearm_x <= -111: Walking (5)
##     :               accel_forearm_x > -111:
##     :               :...magnet_arm_z <= 301: Standing-up (27/2)
##     :                   magnet_arm_z > 301: Stading (3/1)
##     accel_belt_z > 42:
##     :...gyros_arm_x <= -1.43:
##         :...magnet_forearm_x > -303: Sitting (13)
##         :   magnet_forearm_x <= -303:
##         :   :...total_accel_arm <= 25: Walking (3)
##         :       total_accel_arm > 25: Sitting-down (3)
##         gyros_arm_x > -1.43:
##         :...accel_dumbbell_y <= 157: Sitting (5)
##             accel_dumbbell_y > 157:
##             :...pitch_belt > 6.56: Stading (11)
```

```
##                 pitch_belt <= 6.56:
##                 :...yaw_belt <= -88: Standing-up (26)
##                     yaw_belt > -88:
##                     :...accel_forearm_z <= -140: Stading (7)
##                         accel_forearm_z > -140: Standing-up (7)
##
## SubTree [S11]
##
## yaw_belt > -88.2: Sitting-down (77)
## yaw_belt <= -88.2:
## :...roll_arm <= 84.2: Sitting-down (18)
##     roll_arm > 84.2:
##     :...pitch_forearm <= -1.88: Sitting-down (7)
##         pitch_forearm > -1.88:
##         :...pitch_arm <= -36.4: Sitting-down (6)
##             pitch_arm > -36.4:
##             :...magnet_arm_x <= -367: Stading (7)
##                 magnet_arm_x > -367:
##                 :...yaw_belt <= -89.6: Stading (4)
##                     yaw_belt > -89.6:
##                     :...accel_dumbbell_z <= -23: Stading (3/1)
##                         accel_dumbbell_z > -23: Standing-up (111/1)
##
## SubTree [S12]
##
## total_accel_belt > 11: Stading (6)
## total_accel_belt <= 11:
## :...magnet_forearm_y > 927:
##     :...yaw_belt <= -87.5: Standing-up (19/1)
##     :   yaw_belt > -87.5: Sitting (4)
##     magnet_forearm_y <= 927:
##     :...gyros_forearm_x <= -0.72: Sitting-down (7)
##         gyros_forearm_x > -0.72:
##         :...yaw_dumbbell <= 21.6085: Sitting-down (2)
##             yaw_dumbbell > 21.6085:
##             :...accel_arm_x <= 106: Sitting (74)
##                 accel_arm_x > 106:
##                 :...gyros_belt_z <= 0: Sitting-down (3)
##                     gyros_belt_z > 0: Sitting (6)
##
## SubTree [S13]
##
## magnet_forearm_y <= 106: Standing-up (2)
## magnet_forearm_y > 106: Sitting-down (10/1)
```

```
##
## SubTree [S14]
##
## accel_forearm_y <= -49: Sitting (2)
## accel_forearm_y > -49:
## :...gyros_arm_x <= -0.92: Standing-up (4/1)
##     gyros_arm_x > -0.92: Stading (26)
##
## SubTree [S15]
##
## magnet_dumbbell_z > 78:
## :...gyros_arm_x <= -2.81: Standing-up (32)
## :   gyros_arm_x > -2.81:
## :   :...magnet_forearm_x <= -314: Walking (41)
## :       magnet_forearm_x > -314:
## :       :...gyros_belt_z <= 0: Stading (15)
## :           gyros_belt_z > 0: Sitting (2)
## magnet_dumbbell_z <= 78:
## :...roll_belt <= 0.58:
##     :...magnet_dumbbell_z <= 10: Sitting-down (2)
##     :   magnet_dumbbell_z > 10:
##     :   :...roll_forearm <= 133: Stading (2)
##     :       roll_forearm > 133: Sitting (6/1)
##     roll_belt > 0.58:
##     :...accel_dumbbell_y <= -120:
##         :...total_accel_dumbbell <= 16: Standing-up (3)
##         :   total_accel_dumbbell > 16: Stading (3)
##         accel_dumbbell_y > -120:
##         :...yaw_belt <= -93.3:
##             :...roll_forearm <= -10: Standing-up (9)
##             :   roll_forearm > -10: Walking (5)
##             yaw_belt > -93.3:
##             :...accel_forearm_x > -154: Standing-up (240)
##                 accel_forearm_x <= -154:
##                 :...accel_arm_y <= 4: Standing-up (35)
##                     accel_arm_y > 4: Walking (4)
##
## SubTree [S16]
##
## magnet_belt_x > 23: Stading (3)
## magnet_belt_x <= 23:
## :...roll_belt > 124: Sitting (13)
##     roll_belt <= 124:
##     :...yaw_dumbbell <= -61.3897: Sitting (11)
```

```
##         yaw_dumbbell > -61.3897:
##         :...accel_forearm_x > 74: Stading (2)
##             accel_forearm_x <= 74:
##             :...accel_arm_x <= 396: Standing-up (74/1)
##                 accel_arm_x > 396: Walking (4/1)
##
## SubTree [S17]
##
## gyros_arm_y <= 0.95: Walking (4)
## gyros_arm_y > 0.95:
## :...yaw_belt > 2.81: Sitting (7)
##     yaw_belt <= 2.81:
##     :...yaw_forearm <= 104: Standing-up (58)
##         yaw_forearm > 104: Sitting (4/1)
##
## SubTree [S18]
##
## roll_forearm > 126:
## :...total_accel_dumbbell > 23:
## :   :...pitch_forearm > 11.3: Sitting-down (18)
## :   :   pitch_forearm <= 11.3:
## :   :   :...gyros_forearm_z <= 0.74: Standing-up (29/1)
## :   :       gyros_forearm_z > 0.74: Sitting-down (2)
## :   total_accel_dumbbell <= 23:
## :   :...roll_arm <= -17.7:
## :       :...roll_belt > 125: Sitting (3)
## :       :   roll_belt <= 125:
## :       :   :...magnet_dumbbell_y <= -531: Standing-up (2/1)
## :       :       magnet_dumbbell_y > -531: Sitting-down (24)
## :       roll_arm > -17.7:
## :       :...gyros_arm_x > 2.68:
## :           :...pitch_forearm <= 10.1: Standing-up (6)
## :           :   pitch_forearm > 10.1: Sitting (10)
## :           gyros_arm_x <= 2.68:
## :           :...pitch_belt > 26.1:
## :               :...accel_arm_x <= 102: Standing-up (11)
## :               :   accel_arm_x > 102: Sitting-down (3/1)
## :               pitch_belt <= 26.1:
## :               :...pitch_forearm <= 31.8:
## :                   :...roll_belt <= 16.6:
## :                   :   :...yaw_belt <= -93.2: Walking (8)
## :                   :   :   yaw_belt > -93.2: Standing-up (4)
## :                   :   roll_belt > 16.6:
## :                   :   :...gyros_forearm_x > 0.74:
```

```
## :                   :       :...roll_forearm <= 136: Walking (4)
## :                   :       :   roll_forearm > 136: Stading (4)
## :                   :       gyros_forearm_x <= 0.74:
## :                   :       :...magnet_arm_z > 265: Stading (194/1)
## :                   :           magnet_arm_z <= 265:
## :                   :           :...yaw_forearm <= 96.2: Stading (17)
## :                   :               yaw_forearm > 96.2: Walking (5)
## :                   pitch_forearm > 31.8:
## :                   :...pitch_forearm > 64: Sitting-down (10)
## :                       pitch_forearm <= 64:
## :                       :...gyros_forearm_y <= -3.47: Standing-up (7)
## :                           gyros_forearm_y > -3.47:
## :                           :...magnet_arm_y <= 330:
## :                               :...yaw_belt <= -3.93: Walking (194/1)
## :                               :   yaw_belt > -3.93: Sitting (4/1)
## :                               magnet_arm_y > 330:
## :                               :...accel_dumbbell_z > 102: Walking (3)
## :                                   accel_dumbbell_z <= 102:
## :                                   :...roll_forearm <= 134: Walking (2)
## :                                       roll_forearm > 134: Stading (44)
## roll_forearm <= 126:
## :...accel_dumbbell_y <= -50:
##     :...magnet_belt_z > -284: Sitting (8)
##     :   magnet_belt_z <= -284:
##     :   :...yaw_belt > 1.18: Stading (42)
##     :       yaw_belt <= 1.18:
##     :       :...magnet_arm_x <= -259: Sitting-down (3)
##     :           magnet_arm_x > -259:
##     :           :...pitch_arm <= -63: Walking (2)
##     :               pitch_arm > -63: Standing-up (28)
##     accel_dumbbell_y > -50:
##     :...magnet_dumbbell_y > 444:
##         :...total_accel_belt <= 4: Sitting-down (43)
##         :   total_accel_belt > 4:
##         :   :...yaw_belt <= -2.83: Standing-up (105)
##         :       yaw_belt > -2.83:
##         :       :...pitch_belt > 15.2: Walking (392/2)
##         :           pitch_belt <= 15.2:
##         :           :...roll_belt <= 121: Standing-up (5)
##         :               roll_belt > 121: Sitting (12)
##         magnet_dumbbell_y <= 444:
##         :...roll_forearm <= -137:
##             :...pitch_belt > 25.9:
##             :   :...pitch_belt <= 26.8: Sitting-down (21)
```

```
##             :   :   pitch_belt > 26.8: Standing-up (5)
##             :   pitch_belt <= 25.9:
##             :   :...magnet_dumbbell_x <= -556: Standing-up (5)
##             :       magnet_dumbbell_x > -556:
##             :       :...yaw_belt > -4: Sitting-down (12)
##             :           yaw_belt <= -4:
##             :           :...pitch_forearm <= 65.6: Walking (123)
##             :               pitch_forearm > 65.6: Sitting-down (4)
##             roll_forearm > -137:
##             :...roll_forearm > 118:
##                 :...roll_arm <= 45.1: Sitting-down (28)
##                 :   roll_arm > 45.1:
##                 :   :...pitch_forearm > 52.3: Sitting-down (4)
##                 :       pitch_forearm <= 52.3:
##                 :       :...gyros_dumbbell_z > 0.16: Standing-up (9)
##                 :           gyros_dumbbell_z <= 0.16:
##                 :           :...roll_forearm <= 125: Walking (45)
##                 :               roll_forearm > 125: Stading (2)
##                 roll_forearm <= 118:
##                 :...magnet_belt_x > 51:
##                     :...roll_belt <= 16.6: Sitting-down (8)
##                     :   roll_belt > 16.6:
##                     :   :...yaw_belt <= 166: Stading (4)
##                     :       yaw_belt > 166: Standing-up (13)
##                     magnet_belt_x <= 51:
##                     :...magnet_dumbbell_y > 376:
##                         :...pitch_belt > 17.5: Standing-up (67)
##                         :   pitch_belt <= 17.5:
##                         :   :...accel_dumbbell_z > 29:
##                         :       :...yaw_belt <= -1.6: Standing-up (24)
##                         :       :   yaw_belt > -1.6: Sitting-down (3)
##                         :       accel_dumbbell_z <= 29:
##                         :       :...magnet_dumbbell_z <= -40:
##                         :           :...yaw_arm <= 5.14: Sitting-down (141/3)
##                         :           :   yaw_arm > 5.14: Standing-up (4)
##                         :           magnet_dumbbell_z > -40: [S20]
##                         magnet_dumbbell_y <= 376:
##                         :...gyros_arm_x <= 2.04:
##                             :...roll_forearm > 113:
##                             :   :...accel_arm_z <= 71: Standing-up (7)
##                             :   :   accel_arm_z > 71:
##                             :   :   :...yaw_belt <= -2.21: Sitting-down (15)
##                             :   :       yaw_belt > -2.21: Standing-up (2)
##                             :   roll_forearm <= 113:
```

```
##                             :   :...yaw_belt > -8.95:
##                             :       :...roll_belt <= 115: Standing-up (18)
##                             :       :   roll_belt > 115: Sitting-down (482/6)
##                             :       yaw_belt <= -8.95:
##                             :       :...gyros_belt_x > -0.08: Sitting-down (283/
1)
##                             :           gyros_belt_x <= -0.08: [S21]
##                             gyros_arm_x > 2.04:
##                             :...magnet_dumbbell_x <= -550: Standing-up (15)
##                                 magnet_dumbbell_x > -550:
##                                 :...total_accel_forearm <= 19: Standing-up (6)
##                                     total_accel_forearm > 19: [S22]
##
## SubTree [S19]
##
## magnet_dumbbell_z > 281:
## :...accel_dumbbell_z <= 24:
## :   :...magnet_dumbbell_y > 214:
## :   :   :...gyros_arm_y <= -1.12: Standing-up (5/1)
## :   :   :   gyros_arm_y > -1.12: Sitting-down (228/1)
## :   :   magnet_dumbbell_y <= 214:
## :   :   :...magnet_dumbbell_y <= 164: Stading (32)
## :   :       magnet_dumbbell_y > 164:
## :   :       :...roll_dumbbell > 24.27127: Stading (7/1)
## :   :           roll_dumbbell <= 24.27127:
## :   :           :...roll_arm <= 84.4: Sitting-down (2)
## :   :               roll_arm > 84.4: Standing-up (21)
## :   accel_dumbbell_z > 24:
## :   :...roll_dumbbell <= 27.03025:
## :       :...gyros_belt_x <= 0.02: Standing-up (24/1)
## :       :   gyros_belt_x > 0.02: Sitting-down (6/1)
## :       roll_dumbbell > 27.03025:
## :       :...magnet_belt_y <= 466: Walking (7)
## :           magnet_belt_y > 466:
## :           :...roll_belt <= 0.51: Walking (8)
## :               roll_belt > 0.51:
## :               :...accel_arm_y > 198: Walking (4)
## :                   accel_arm_y <= 198:
## :                   :...magnet_dumbbell_y <= 299: Sitting (140)
## :                       magnet_dumbbell_y > 299: Sitting-down (3/1)
## magnet_dumbbell_z <= 281:
## :...accel_dumbbell_z > 31:
##     :...magnet_dumbbell_z > 190: Sitting (18)
##     :   magnet_dumbbell_z <= 190:
```

```
##     :   :...total_accel_arm <= 4: Sitting-down (9)
##     :       total_accel_arm > 4:
##     :       :...magnet_dumbbell_x > 42:
##     :           :...gyros_forearm_x <= -0.14: Walking (4)
##     :           :   gyros_forearm_x > -0.14: Stading (24/1)
##     :           magnet_dumbbell_x <= 42:
##     :           :...accel_forearm_x <= -194: Walking (3/1)
##     :               accel_forearm_x > -194:
##     :               :...yaw_dumbbell <= 68.57295: Stading (3)
##     :                   yaw_dumbbell > 68.57295:
##     :                   :...magnet_dumbbell_y > 244: Standing-up (92)
##     :                       magnet_dumbbell_y <= 244:
##     :                       :...yaw_belt <= -90.7: Stading (5)
##     :                           yaw_belt > -90.7: Standing-up (3)
##     accel_dumbbell_z <= 31:
##     :...yaw_belt <= -93.3:
##         :...magnet_dumbbell_y > 258: Walking (259/2)
##         :   magnet_dumbbell_y <= 258:
##         :   :...accel_belt_x > -15: Sitting (2)
##         :       accel_belt_x <= -15:
##         :       :...yaw_belt > -93.6: Stading (54)
##         :           yaw_belt <= -93.6:
##         :           :...roll_belt <= 1.53: Walking (7)
##         :               roll_belt > 1.53: Stading (2)
##         yaw_belt > -93.3:
##         :...pitch_belt <= -41.6:
##             :...pitch_arm > 72: Sitting-down (10)
##             :   pitch_arm <= 72:
##             :   :...yaw_belt > 166:
##             :       :...pitch_arm <= -54.4: Stading (4)
##             :       :   pitch_arm > -54.4: Standing-up (17)
##             :       yaw_belt <= 166:
##             :       :...roll_belt <= 125:
##             :           :...magnet_belt_x > 166:
##             :           :   :...pitch_belt <= -42.1:
##             :           :   :   :...roll_dumbbell <= 62.39419: Stading (43)
##             :           :   :   :   roll_dumbbell > 62.39419: Walking (8/1)
##             :           :   :   pitch_belt > -42.1:
##             :           :   :   :...accel_belt_z > -156: Stading (4)
##             :           :   :       accel_belt_z <= -156: [S23]
##             :           :   magnet_belt_x <= 166:
##             :           :   :...accel_belt_z <= -158:
##             :           :       :...magnet_dumbbell_y > 241: Walking (190)
##             :           :       :   magnet_dumbbell_y <= 241:
```

```
##             :           :       :   :...gyros_arm_x <= 1.08: Walking (19)
##             :           :       :       gyros_arm_x > 1.08: Stading (3)
##             :           :       accel_belt_z > -158:
##             :           :       :...pitch_belt > -42: Walking (54/2)
##             :           :           pitch_belt <= -42:
##             :           :           :...magnet_dumbbell_x > -542: Walking (16/1)
##             :           :               magnet_dumbbell_x <= -542: [S24]
##             :           roll_belt > 125:
##             :           :...magnet_belt_z <= -329: Sitting-down (2)
##             :               magnet_belt_z > -329:
##             :               :...gyros_belt_x > 0.27: Standing-up (3)
##             :                   gyros_belt_x <= 0.27:
##             :                   :...accel_belt_z <= -164: Standing-up (2/1)
##             :                       accel_belt_z > -164:
##             :                       :...magnet_belt_x > 161: Stading (67)
##             :                           magnet_belt_x <= 161:
##             :                           :...yaw_belt <= 163: Stading (2)
##             :                               yaw_belt > 163: Walking (2)
##             pitch_belt > -41.6:
##             :...accel_dumbbell_y > 151:
##                 :...magnet_dumbbell_z <= 37:
##                 :   :...roll_forearm <= 126: Sitting-down (45)
##                 :   :   roll_forearm > 126:
##                 :   :   :...magnet_dumbbell_z <= 0: Sitting-down (5)
##                 :   :       magnet_dumbbell_z > 0: Standing-up (15/1)
##                 :   magnet_dumbbell_z > 37:
##                 :   :...accel_forearm_x <= -77:
##                 :       :...pitch_forearm > 44:
##                 :       :   :...yaw_belt <= -87.8: Standing-up (4)
##                 :       :   :   yaw_belt > -87.8: Stading (3)
##                 :       :   pitch_forearm <= 44:
##                 :       :   :...accel_arm_y > 197:
##                 :       :       :...accel_forearm_y <= 169: Stading (15/1)
##                 :       :       :   accel_forearm_y > 169: Walking (11)
##                 :       :       accel_arm_y <= 197:
##                 :       :       :...yaw_belt <= -88.6:
##                 :       :           :...pitch_forearm <= 31.2: Walking (49)
##                 :       :           :   pitch_forearm > 31.2: Sitting (15)
##                 :       :           yaw_belt > -88.6:
##                 :       :           :...magnet_dumbbell_x > -535: Walking (237/3)
##                 :       :               magnet_dumbbell_x <= -535:
##                 :       :               :...yaw_belt <= -87.8: Stading (4)
##                 :       :                   yaw_belt > -87.8: Walking (3)
##                 :       accel_forearm_x > -77:
```

```
##                  :       :...pitch_belt <= -0.28: Sitting (4)
##                  :           pitch_belt > -0.28:
##                  :           :...yaw_belt <= -88.3:
##                  :               :...yaw_belt <= -88.6: Sitting (6/1)
##                  :               :   yaw_belt > -88.6: Standing-up (22/2)
##                  :               yaw_belt > -88.3:
##                  :               :...accel_belt_z <= 35: Standing-up (33/1)
##                  :                   accel_belt_z > 35:
##                  :                   :...magnet_arm_y > 444: Standing-up (10/1)
##                  :                       magnet_arm_y <= 444:
##                  :                       :...gyros_arm_y > 1.86: Sitting (3/1)
##                  :                           gyros_arm_y <= 1.86:
##                  :                           :...accel_arm_y <= 234: Stading (111/
5)
##                  :                               accel_arm_y > 234: [S25]
##                  accel_dumbbell_y <= 151:
##                  :...magnet_belt_z > -289:
##                      :...roll_dumbbell <= -119.2942:
##                      :   :...total_accel_dumbbell <= 3: Standing-up (2)
##                      :   :   total_accel_dumbbell > 3: Stading (3)
##                      :   roll_dumbbell > -119.2942:
##                      :   :...magnet_forearm_x <= -607: Stading (7/2)
##                      :       magnet_forearm_x > -607:
##                      :       :...gyros_arm_y > 0.67: Sitting-down (2)
##                      :           gyros_arm_y <= 0.67:
##                      :           :...pitch_forearm <= -12.3: Sitting-down (2/1)
##                      :               pitch_forearm > -12.3: Sitting (28)
##                      magnet_belt_z <= -289:
##                      :...magnet_belt_z <= -447:
##                          :...accel_forearm_z <= -19: Sitting (9)
##                          :   accel_forearm_z > -19: Walking (20)
##                          magnet_belt_z > -447:
##                          :...pitch_arm <= -49.8:
##                              :...yaw_arm > 112: Stading (9)
##                              :   yaw_arm <= 112:
##                              :   :...magnet_dumbbell_y > 325: Walking (21)
##                              :       magnet_dumbbell_y <= 325: [S26]
##                              pitch_arm > -49.8:
##                              :...magnet_arm_z <= -504:
##                                  :...accel_dumbbell_x <= -16: Stading (14)
##                                  :   accel_dumbbell_x > -16: Standing-up (19/1)
##                                  magnet_arm_z > -504:
##                                  :...accel_dumbbell_z <= -196:
##                                      :...magnet_dumbbell_z <= 36: [S27]
```

```
##                                       :   magnet_dumbbell_z > 36:
##                                       :   :...yaw_belt <= -88.3: [S28]
##                                       :       yaw_belt > -88.3: [S29]
##                                       accel_dumbbell_z > -196:
##                                       :...pitch_forearm <= -17.7: [S30]
##                                           pitch_forearm > -17.7:
##                                           :...pitch_belt > 14.9: [S31]
##                                               pitch_belt <= 14.9:
##                                               :...magnet_forearm_y <= -629: [S32]
##                                                   magnet_forearm_y > -629:
##                                                   :...gyros_forearm_y <= -3.84: [S3
3]
##                                                       gyros_forearm_y > -3.84:
##                                                       :...gyros_belt_z <= -0.23: [S
34]
##                                                           gyros_belt_z > -0.23: [S3
5]
##
## SubTree [S20]
##
## total_accel_dumbbell <= 17: Walking (30)
## total_accel_dumbbell > 17: Sitting-down (28)
##
## SubTree [S21]
##
## gyros_belt_x <= -0.11: Standing-up (2)
## gyros_belt_x > -0.11: Sitting-down (4)
##
## SubTree [S22]
##
## accel_dumbbell_y <= -23: Standing-up (2)
## accel_dumbbell_y > -23:
## :...magnet_arm_y <= -27: Standing-up (2)
##     magnet_arm_y > -27: Sitting-down (45)
##
## SubTree [S23]
##
## total_accel_dumbbell <= 16: Stading (3/1)
## total_accel_dumbbell > 16: Walking (18)
##
## SubTree [S24]
##
## accel_dumbbell_z <= -150: Walking (2)
## accel_dumbbell_z > -150: Stading (20)
```

```
##
## SubTree [S25]
##
## roll_dumbbell <= 62.54677: Stading (3)
## roll_dumbbell > 62.54677: Standing-up (4)
##
## SubTree [S26]
##
## magnet_forearm_y <= 115: Sitting-down (7)
## magnet_forearm_y > 115: Standing-up (5)
##
## SubTree [S27]
##
## gyros_arm_z <= 0.15: Sitting-down (34/2)
## gyros_arm_z > 0.15: Standing-up (4/1)
##
## SubTree [S28]
##
## magnet_dumbbell_y <= 334: Sitting (57)
## magnet_dumbbell_y > 334: Standing-up (2/1)
##
## SubTree [S29]
##
## magnet_belt_y <= 602: Sitting (7)
## magnet_belt_y > 602:
## :...accel_forearm_z > -110: Standing-up (10/1)
##     accel_forearm_z <= -110:
##     :...yaw_belt <= -87.7:
##         :...total_accel_arm > 14: Stading (140/1)
##         :   total_accel_arm <= 14:
##         :   :...magnet_forearm_y <= 700: Stading (4)
##         :       magnet_forearm_y > 700: Sitting (5)
##         yaw_belt > -87.7:
##         :...accel_forearm_x <= -132: Walking (19)
##             accel_forearm_x > -132:
##             :...total_accel_dumbbell <= 29: Stading (17/1)
##                 total_accel_dumbbell > 29:
##                 :...magnet_forearm_x <= -506: Walking (5)
##                     magnet_forearm_x > -506: Stading (4)
##
## SubTree [S30]
##
## gyros_arm_x <= 0.14: Sitting-down (4/1)
## gyros_arm_x > 0.14: Standing-up (27)
```

```
##
## SubTree [S31]
##
## roll_belt <= 117: Standing-up (6)
## roll_belt > 117:
## :...pitch_forearm <= 20.1: Stading (2)
##     pitch_forearm > 20.1: Walking (23)
##
## SubTree [S32]
##
## accel_forearm_z <= -130: Standing-up (10)
## accel_forearm_z > -130:
## :...roll_forearm <= -84.3: Sitting-down (9)
##     roll_forearm > -84.3: Stading (22)
##
## SubTree [S33]
##
## accel_belt_y > 21: Sitting (2)
## accel_belt_y <= 21:
## :...gyros_forearm_y > -3.87: Sitting-down (2)
##     gyros_forearm_y <= -3.87:
##     :...magnet_arm_z <= 432: Stading (9)
##         magnet_arm_z > 432:
##         :...gyros_arm_y <= -0.29: Stading (3)
##             gyros_arm_y > -0.29: Standing-up (15)
##
## SubTree [S34]
##
## yaw_arm > 100: Sitting-down (7)
## yaw_arm <= 100:
## :...roll_belt <= 119: Walking (8)
##     roll_belt > 119:
##     :...gyros_belt_z <= -0.38: Sitting (2)
##         gyros_belt_z > -0.38: Stading (8)
##
## SubTree [S35]
##
## gyros_dumbbell_y <= -0.31:
## :...magnet_dumbbell_z <= 261: Stading (18/2)
## :   magnet_dumbbell_z > 261: Standing-up (12)
## gyros_dumbbell_y > -0.31:
## :...magnet_dumbbell_z <= -17:
##     :...roll_belt > 16.6: Stading (62)
##     :   roll_belt <= 16.6:
```

```
##     :   :...magnet_dumbbell_x <= -551: Standing-up (11)
##     :       magnet_dumbbell_x > -551: Sitting-down (6)
##     magnet_dumbbell_z > -17:
##     :...gyros_dumbbell_x <= -0.21:
##         :...accel_dumbbell_x > 5: Sitting (3)
##         :   accel_dumbbell_x <= 5:
##         :   :...gyros_arm_x <= -1.54: Standing-up (4/1)
##         :       gyros_arm_x > -1.54:
##         :       :...roll_dumbbell <= -127.1075: Standing-up (3/1)
##         :           roll_dumbbell > -127.1075: Stading (17)
##         gyros_dumbbell_x > -0.21:
##         :...accel_belt_x <= -22:
##             :...yaw_dumbbell > 97.86987: Walking (3/1)
##             :   yaw_dumbbell <= 97.86987:
##             :   :...yaw_belt > 4.09: Walking (7)
##             :       yaw_belt <= 4.09:
##             :       :...magnet_arm_z > 623: Walking (4)
##             :           magnet_arm_z <= 623:
##             :           :...gyros_dumbbell_x <= 0.47: Stading (39/2)
##             :               gyros_dumbbell_x > 0.47: Walking (2)
##             accel_belt_x > -22:
##             :...yaw_belt > 162:
##                 :...roll_arm <= 9.48: Walking (13)
##                 :   roll_arm > 9.48: Stading (16)
##                 yaw_belt <= 162:
##                 :...gyros_arm_y <= -1.73:
##                     :...magnet_forearm_y <= 246: Walking (3)
##                     :   magnet_forearm_y > 246:
##                     :   :...roll_belt <= 0.37: Sitting (4)
##                     :       roll_belt > 0.37: Stading (19)
##                     gyros_arm_y > -1.73:
##                     :...accel_belt_z > 28:
##                         :...magnet_dumbbell_z <= 59:
##                         :   :...roll_dumbbell <= 51.5691: Stading (11/1)
##                         :   :   roll_dumbbell > 51.5691: Sitting-down (6/3)
##                         :   magnet_dumbbell_z > 59:
##                         :   :...magnet_arm_z <= 14:
##                         :       :...accel_forearm_x <= -129: Walking (10)
##                         :       :   accel_forearm_x > -129:
##                         :       :   :...accel_belt_z <= 42: Walking (4/1)
##                         :       :       accel_belt_z > 42: Stading (16)
##                         :       magnet_arm_z > 14:
##                         :       :...yaw_dumbbell > -79.5973: Stading (118/2)
##                         :           yaw_dumbbell <= -79.5973:
```

```
##                          :           :...pitch_forearm <= 0.89: Stading (2)
##                          :               pitch_forearm > 0.89: Walking (4)
##                          accel_belt_z <= 28:
##                          :...pitch_belt > 14.1:
##                              :...accel_dumbbell_y > -34: Walking (9)
##                              :   accel_dumbbell_y <= -34:
##                              :   :...yaw_belt <= 4.47: Stading (94/1)
##                              :       yaw_belt > 4.47: Walking (2)
##                              pitch_belt <= 14.1:
##                              :...yaw_belt <= -93.1:
##                                  :...magnet_dumbbell_x <= -559: Stading (32)
##                                  :   magnet_dumbbell_x > -559:
##                                  :   :...roll_arm <= 69.5: Walking (4)
##                                  :       roll_arm > 69.5: Sitting-down (2/1)
##                                  yaw_belt > -93.1:
##                                  :...magnet_dumbbell_y <= 125:
##                                      :...magnet_belt_x <= 58: Stading (16)
##                                      :   magnet_belt_x > 58: Sitting (3)
##                                      magnet_dumbbell_y > 125:
##                                      :...gyros_forearm_z > -0.54: Stading (859/2)
##                                          gyros_forearm_z <= -0.54: [S36]
##
## SubTree [S36]
##
## magnet_forearm_y <= -194: Standing-up (3)
## magnet_forearm_y > -194:
## :...pitch_forearm <= -4.99: Standing-up (3/1)
##     pitch_forearm > -4.99: Stading (59/1)
##
##
## Evaluation on training data (14718 cases):
##
##      Decision Tree
##    ----------------
##    Size      Errors
##
##     365  125( 0.8%)   <<
##
##
##     (a)   (b)   (c)   (d)   (e)    <-classified as
##    ----  ----  ----  ----  ----
##    4169    10     4     2          (a): class Sitting-down
##      12  2822     8     1     5    (b): class Standing-up
##       5    13  2540     8     1    (c): class Stading
```

```
##       5     9    15  2377     6    (d): class Walking
##       4     9     2     6  2685    (e): class Sitting
##
##
##  Attribute usage:
##
##  100.00% roll_belt
##   91.64% pitch_forearm
##   80.98% yaw_belt
##   79.30% gyros_belt_z
##   76.94% accel_dumbbell_x
##   71.75% gyros_belt_y
##   67.84% pitch_belt
##   64.97% total_accel_forearm
##   59.75% yaw_arm
##   57.74% magnet_dumbbell_z
##   57.30% gyros_dumbbell_y
##   37.31% magnet_arm_z
##   35.18% accel_dumbbell_y
##   31.08% accel_dumbbell_z
##   29.00% gyros_arm_x
##   28.23% magnet_dumbbell_y
##   27.62% magnet_belt_z
##   26.07% pitch_arm
##   24.11% roll_forearm
##   19.67% magnet_belt_x
##   16.16% accel_belt_z
##   13.67% accel_belt_x
##   12.32% gyros_forearm_y
##   12.30% gyros_arm_y
##   11.88% magnet_forearm_y
##   11.67% gyros_belt_x
##   10.76% gyros_dumbbell_x
##    9.34% accel_forearm_z
##    9.12% gyros_forearm_z
##    8.30% magnet_belt_y
##    7.56% accel_forearm_x
##    6.55% roll_arm
##    6.37% total_accel_dumbbell
##    6.36% magnet_dumbbell_x
##    5.48% roll_dumbbell
##    4.83% magnet_forearm_x
##    4.77% gyros_forearm_x
##    4.66% total_accel_belt
```

```
##    4.33% accel_arm_y
##    4.08% magnet_arm_x
##    3.70% accel_arm_x
##    3.64% total_accel_arm
##    3.11% yaw_dumbbell
##    3.00% magnet_arm_y
##    1.61% magnet_forearm_z
##    0.57% yaw_forearm
##    0.39% accel_forearm_y
##    0.38% gyros_dumbbell_z
##    0.26% gyros_arm_z
##    0.21% accel_belt_y
##    0.16% accel_arm_z
##
##
## Time: 2.2 secs
```